IR NO. 69-74

INFORMAL REPORT

HYDROGRAPHIC OPERATIONS IN BLUEFIELDS, NICARAGUA CONDUCTED UNDER THE HARBOR SURVEY ASSISTANCE PROGRAM (HARSAP)

AUGUST 1969

NAVAL OCEANOGRAPHIC OFFICE
WASHINGTON, D. C. 20390

INFORMAL REPORT

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ABSTRACT

This survey is the fourth of its type conducted under NAVOCEANO's Harbor Survey Assistance Program, a program designed to assist Latin-American countries in conducting hydrographic surveys of essential areas of their coastal waterways. The purpose of this survey was to obtain up-to-date information for the publication of accurate navigational charts and nautical publications of Bluefields Bay, Nicaragua, and to provide technical training and guidance to personnel of the Direccion General de Cartografia, Nicaraguan government.

The methods and techniques used and the results obtained are presented.

Coastal Surveys Branch
Bathymetry Division
Hydrographic Surveys Department

This report has been reviewed and is approved for release as an UNCLASSIFIED Report.

22 August 1969
DATE

W. A. FOSTER, JR.
Director,
Bathymetry Division

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INTRODUCTION

In 1964, the Harbor Survey Assistance Program (HARSAP) was initiated. It is a program of the U.S. Navy to provide a hydrographic mission to assist other countries in conducting surveys of harbors and approaches, and has the dual purpose of: (1) obtaining information for the publication of accurate nautical charts and sailing directions, (2) provide technical training and guidance to personnel of participating countries.

The charting of foreign waters and the high seas is the responsibility of the U.S. Naval Oceanographic Office (NAVOCEANO). This Office has long realized the tremendous size of this mission and in the past has planned and initiated many actions designed to help accomplish its task. HARSAP is one such plan that should be of mutual benefit to the United States and the participating nation. It should accomplish the mission of providing charts for safe navigation and in turn develop a hydrographic surveying and mapping capability in nations who so desire it.

Under the terms of a HARSAP agreement with the host country, NAVOCEANO furnishes on a loan basis, the required technical equipment and its representatives provide the necessary training and direct the technical phase of the survey operation. The majority of the hydrographic survey and data processing is actually conducted by the indigenous personnel.

The Nicaraguan government and NAVOCEANO agreed to carry out a hydro-

graphic survey of Bluefields Bay and its approaches, under the HARSAP program. It was agreed that Direccion General de Cartografia (DGC) would provide:

1. Personnel for establishing geodetic control.

2. Personnel for conducting the hydrographic survey.

3. Launch or other craft suitable for hydrographic surveying.

4. Required transportation to, from, and within the survey area vicinity.

5. Material for the construction of signals and station monuments, and equipment needed to modify the launch.

6. Office and storage space, and office materials as required.

7. Necessary geodetic values, station descriptions, topographic maps and aerial photographs.

In addition, DGC agreed to establish a portable tide gage.

The U.S. Naval Oceanographic Office agreed to provide:

1. The required number of hydrographic engineers to advise and assist the Nicaraguan personnel.

2. Necessary instruments to establish geodetic control.

3. Equipment for conducting hydrographic surveys, including radios and ship-shore communication.

4. All necessary office supplies for construction of plotting and smooth sheets.

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3. Equipment for conducting hydrographic surveys, including radios and ship-shore communication.

4. All necessary office supplies for construction of plotting and smooth sheets.

5. The publication of nautical charts and Sailing Directions from the gathered data.

BACKGROUND

Bluefields, a town with a population of about 10,000 lies on the Atlantic coast of Nicaragua, approximately 200 miles from the capital city of Managua. It is the capital of the department of Zelaya, which encompasses in area nearly half the country and holds great potential for its future development. At present Bluefields is isolated from the rest of the country, with no direct highway connection to other towns, and with inadequate telephone service. However, there is regular air service with Managua.

The port of Bluefields is located at El Bluff, just inside the main entrance of the bay. Deep water is confined to a small area, one-half mile long and about 200 yards wide, bounded by shoal water three feet in depth. There is a concrete wharf about 500 feet long and with a depth of 13 feet alongside. An entrance bar at a depth of eleven feet severely limits the number of ships calling at Bluefields.

The Nicaraguan government was investigating the feasibility of constructing a major port on the Atlantic coast. This proposed port would provide a shorter and more economical route to ports in Europe and the east coast of North Central and South America. Bluefields was the most important site under consideration. The only previous hydrographic survey of the area was conducted in 1899 by the USS VIXEN.

Due to suspected changes, the existing hydrographic data was presumed to be unreliable.

The purpose of the survey was to obtain information for the publication of accurate nautical charts for the Bay of Bluefields and its approaches and to provide technical training and guidance to personnel of the Nicaragua government. Also, additional geodetic data were to be obtained in the process of establishing hydrographic survey control stations.

GEODETIC OPERATIONS

In the survey area there were four existing first order stations, previously established by DGC and the Inter-American Geodetic Survey (IAGS) (figure 1). Of these, three were recovered, and the survey was based on these stations.

Stations and landmarks on the eastern side of the survey area, with two exceptions, were positioned by traverses, while those on the western side were positioned by triangulation. All angles were observed with a T-2 theodolite and all distances measured with Electrotapes. Computations of the positions were performed at the field office and at the office of DGC in Managua. All positions established conformed to third order accuracy.

For control of the hydrography, signals 15 to 30 feet high were constructed over selected geodetic stations. These were covered by brightly colored bunting, making them conspicuous signals easily seen

from a distance.

Nature was not firendly. Almost continuous rain made geodetic operations difficult and delayed the survey's completion. Landing on Deer Island by a small boat was difficult due to the large breakers surging onto the beach.

HYDROGRAPHIC OPERATIONS

The survey area was covered by two sheets at 1:10,000 scale (figure 2). The transverse mercator projection was used.

Three sounding boats were separately used throughout the survey. A 40 foot Coast Guard-type cutter was first used for a few days, but was unavailable for the remainder of the survey period. For most of the approach area a 35 foot, 4 foot draft, 120 H. P. fishing boat was used. The same boat could not be used inside the bay, due to the very shallow water and a 25 foot, 2.5 foot draft, 40 H. P. launch was used to survey inside the bay.

A portable Raytheon Fathometer Model DE 723-B was used to determine water depths and gave excellent results. The transducer was "mounted" over the side, so that it was about two feet below the water surface. Lead line checks were taken at the start and end of each survey day to verify the accuracy of sonar depths.

Position control for the hydrographic development was by three point sextant fix. It proved to be an expeditious and accurate method of

positioning. The probable error of each fix was less than 20 yards. Originally it was planned to conduct the survey by obtaining position fixes by means of azimuth instruments located on two known shore stations. However, this method had to be discarded due to unsatisfactory operation of the NAVOCEANO radios.

Sounding lines were spaced at four lines to the inch on sheet number 0.001 and two lines to the inch on sheet number 0.002. One minute fix intervals were used and the fathogram scaled at 15 second sounding intervals. The sounding lines were generally run perpendicular to the shoreline, with cross check lines normal to their direction at an interval of three inches.

The speed of the sounding boat averaged six knots in the outside area, but only four knots inside the bay, because of shallow waters. Nevertheless, the sounding boat ran aground on several occasions.

Surveys of the dock at El Bluff and the Booth Company dock were made. These surveys were conducted at a scale of 1:1,000. Hand lead line soundings were taken every 20 feet along the face of the docks and on sounding lines parallel to the dock at distances of 20, 40, and 60 feet. Pier dimensions and the azimuth of the pier were also carefully measured.

Reconnaissance sounding lines were run on the Escondido River extending some 50 miles from Bluefields to Rama. These were plotted on topographic maps at 1:50,000 scale, using intersection of streams,

sharp bends and other landmarks as control. The line spacing varied with the width of the river, but usually two lines were run along the river. At several known points cross profiles were run. A survey of the Escondido River was conducted by LIVSET, a private company engaged by the Nicaraguan Government to conduct a feasibility study of the Bluefield Harbor.

Altogether, an area of 40 square miles was surveyed, incorporating a total of 800 miles of soundings. The duration of the survey was greatly increased, largely due to inclement weather conditions and difficulties in obtaining a suitable sounding boat.

TIDES AND CURRENTS

Tides in the area were semi-diurnal in character and rarely exceeded 30 inches in amplitude. The tidal ranges were generally small, less than a foot, but could be greatly influenced by meteorological conditions.

A portable tide gage was established at the Booth Company dock and maintained throughout most of the survey period. The tide staff was tied to a bench mark by differential leveling. The collected tide data was reduced to the sounding datum of Mean Low Water, and a calculated tide correction was applied to all soundings.

Current observations were taken at the main channel inside the bay (figure 3). A Roberts Low Velocity current meter together with an Esterline Angus side pen recording unit was used. Two current stations were observed for 24 hour periods at depths of six and ten feet.

The current was found to be a reversing type, with a stronger ebb than flood current. The ebb current set southward with a maximum recorded velocity of 2.2 knots and a duration of about seven hours. The flood current was found to set northward with a maximum recorded velocity of 1.1 knots and a duration of about three hours. The variation between ebb and flood currents was attributed to the flow of the Escondido River.

BOTTOM SAMPLES

Bottom samples were obtained with an Orange Peel Sampler at approximate intervals of three inches square on the boat sheet. The position of each sample was determined by sextant angles. A total of 78 bottom samples were taken.

Analysis as to type of sediment was made in the field and entered on the smooth sheets. A soft mud bottom was found to exist throughout the entire survey area, except for several places in the bay which were composed largely of shells. Generally, good holding ground is available for ships' anchorage. Positions and resultant analysis of these samples are shown in figures 3 and Appendix I respectively.

AIDS TO NAVIGATION

Navigation aids in the area were very limited, There were no buoys, no beacons and only one light, that at the summit of El Bluff.

El Bluff is a bold promontory 137 feet high on the eastern side of the entrance to the bay. It is connected northward to the mainland by a narrow strip of land, known as the Haulover. From a distance El Bluff

appears to be an island and itself is a useful navigation aid.

The lighthouse is the best and most important navigation aid in the area. It was also used as a hydrographic control station.

Name and Location	Position Lat Long	Characteristic Fl. W	Ht of Light Above HW(ft)	Visibility Naut. Mi.	Structure Height
El Bluff Light at Summit of El Bluff	11°59'33"N 83°41'02"W	Period 3.8 sec Fl 0.3 sec ec 3.5 sec Cp 800	163	14	Red Skeleton Iron Tower 25 feet

In the bay, painted barrels on pilings marked the channel from El Bluff to the Escondido River and from the latter to Bluefields. Three wrecks were positioned, two of which were in the main channel entrance to the bay.

WEATHER

The weather, briefly stated, was wet. The average amount of rain exceeds 200 inches per year, and is heavy and frequent. During the survey it rained almost incessantly for days at a time, and as much as six inches in 24 hours. Temperature and humidity were high throughout the survey period. The daily average temperature was 86°F.

Northeast winds prevail throughout the year, with northwest and north winds next in order. From June through August the northeast wind was steady and very fresh (20 mph), causing a good deal of sea and swell. There were several days when it was impossible to survey due to the rough seas.

COMPILATION OF FIELD DATA

All field data was reduced. Geodetic data was checked, positions

were calculated to both grid and geographic values, results were tabulated, and station descriptions were written.

Scaled soundings were checked and observed tide corrections applied. Where observed tides were not available, predicted tides were used. The difference between observed and predicted tides was very small.

Two smooth sheets were constructed at 1:10,000 scale. The standard method of smooth plotting was followed. On overlays, positions were plotted by three arm protractors, checked and then transferred onto the smooth sheets, where they were properly annotated. On these lines, soundings were entered in pencil and then selected soundings inked, so as to show an accurate configuration of the bottom topography. Contour curves were drawn for depths of 6, 18 and 36 feet. Current and bottom sample information were also entered on the smooth sheets. Sub-plans of the two docks were drawn on the sheets at a scale of 1:1,000.

A temporary shoreline was drawn from maps at 1:50,000 scale. It is hoped that in the near future new aerial photography may be flown at a larger scale, so as to provide a more accurate shoreline.

PERSONNEL CONTACT

Direccion General de Cartografia was the immediate organization through which the survey was accomplished. Much credit for help and cooperation goes to its Director, Mr. Cristobal Rugama. The hydrographic survey personnel of DGC showed great interest in the work and a desire to do a good job. Training in the techniques of hydrographic surveying was given to them, and they quickly grasped the methods involved.

LIVSET was a consultant engineering firm contracted by Nicaragua and the United Nations to study the development of the Atlantic Coast of Nicaragua. They were well supported in funds, equipment and personnel; including a hydrographic engineer from the French Hydrographic Office. LIVSET's cooperation and aid included:

1. Payment for the rental of two sounding boats.
2. Payment for part of the field expenses.
3. Use of their equipment.
4. The survey of the Escondido River.
5. Assistance of their hydrographic engineer for the survey inside the bay.

We are much indebted to Mr. A.J. Stammers, Resident Engineer, and Mr. Jean Bourgoin, Hydrographic Engineer.

The Inter-American Geodetic Survey was another organization which greatly contributed to the work being accomplished. They provided not only a means of communication between NAVOCEANO and its field personnel, but also transportation and liaison with other agencies. The cooperation of IAGS personnel and its Officer in Charge, Major W. T. Barron is much appreciated.

Many other people were involved in the completion of the work, and to them our appreciation is also shown.

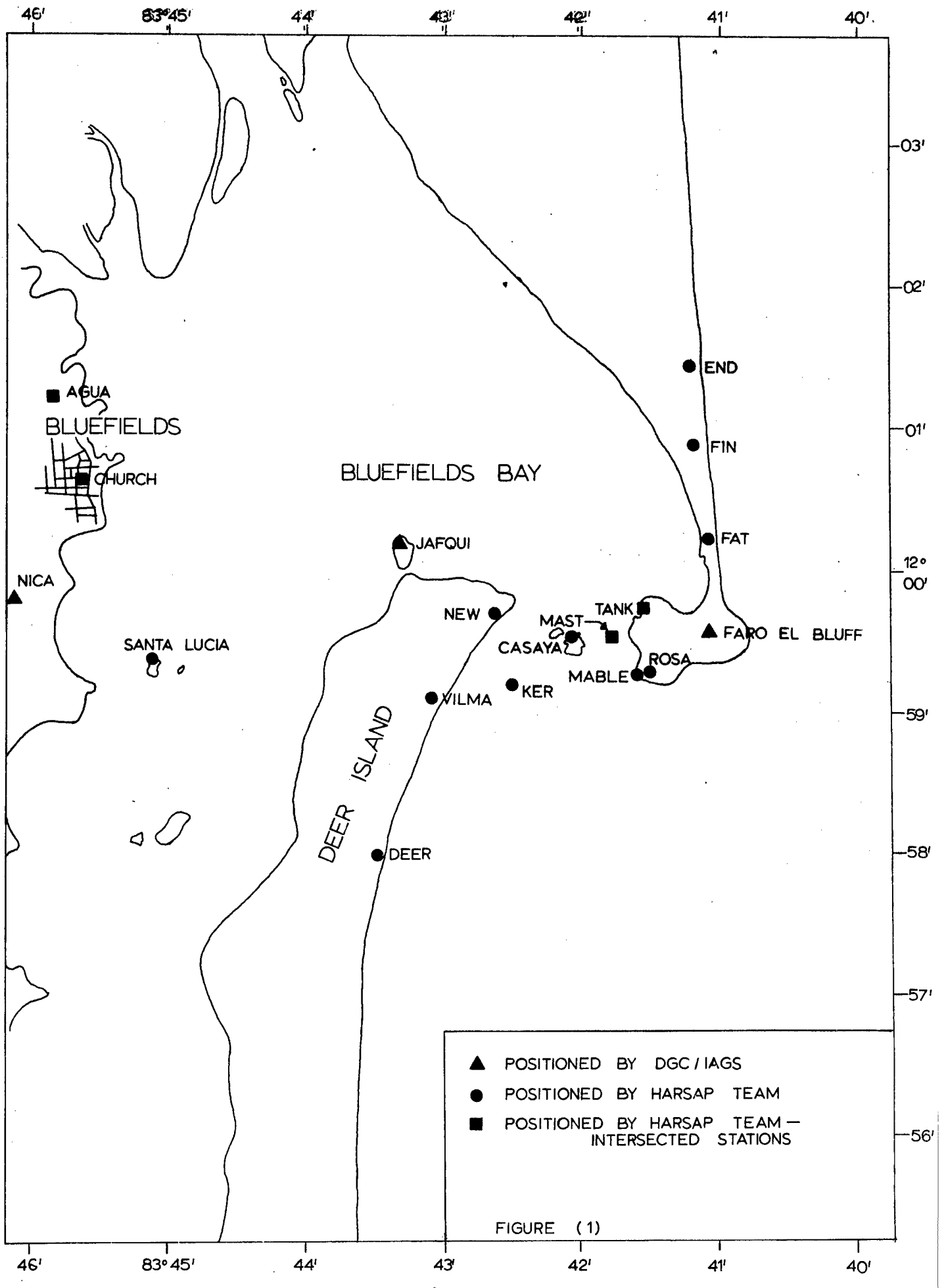
CONCLUSIONS

Much of the success of this survey was due to the interest and labor of DGC hydrographic section personnel. They now have the technical

proficiency to undertake other hydrographic surveys, given the necessary equipment and adequate planning.

The HARSAP program shows much potential, its objectives are very worthwhile, and continued effort should be made to keep the program going and find means to improve it. Perhaps more emphasis could be placed on helping the host government develop a continuous hydrographic program, relative to its needs and capabilities.

If a major port is to be built within the survey area, it must be at El Bluff. Bluefields itself is impracticable because of the very shallow nature of the bay. The site at El Bluff would require dredging to allow the entrance of larger ships. It is hoped that a new port will be built in the area, and that this HARSAP survey has helped towards that objective.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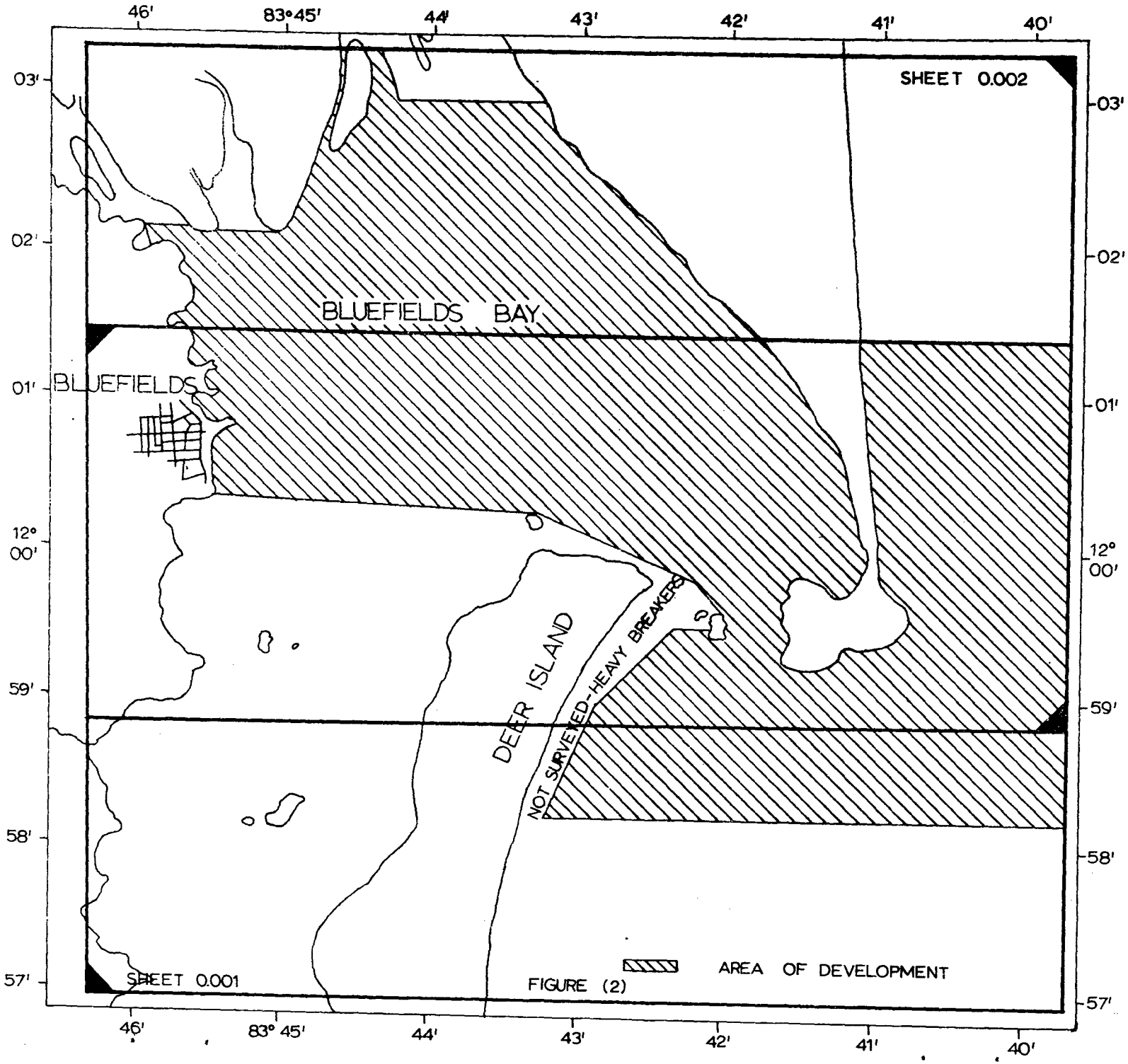
ROSA
MABLE
KER
VILMA
SANTA LUCIA
DEER ISLAND
DEER
POSITIONED BY DGC / IAGS
POSITIONED BY HARSAP TEAM
POSITIONED BY HARSAP TEAM — INTERSECTED STATIONS

FIGURE (1)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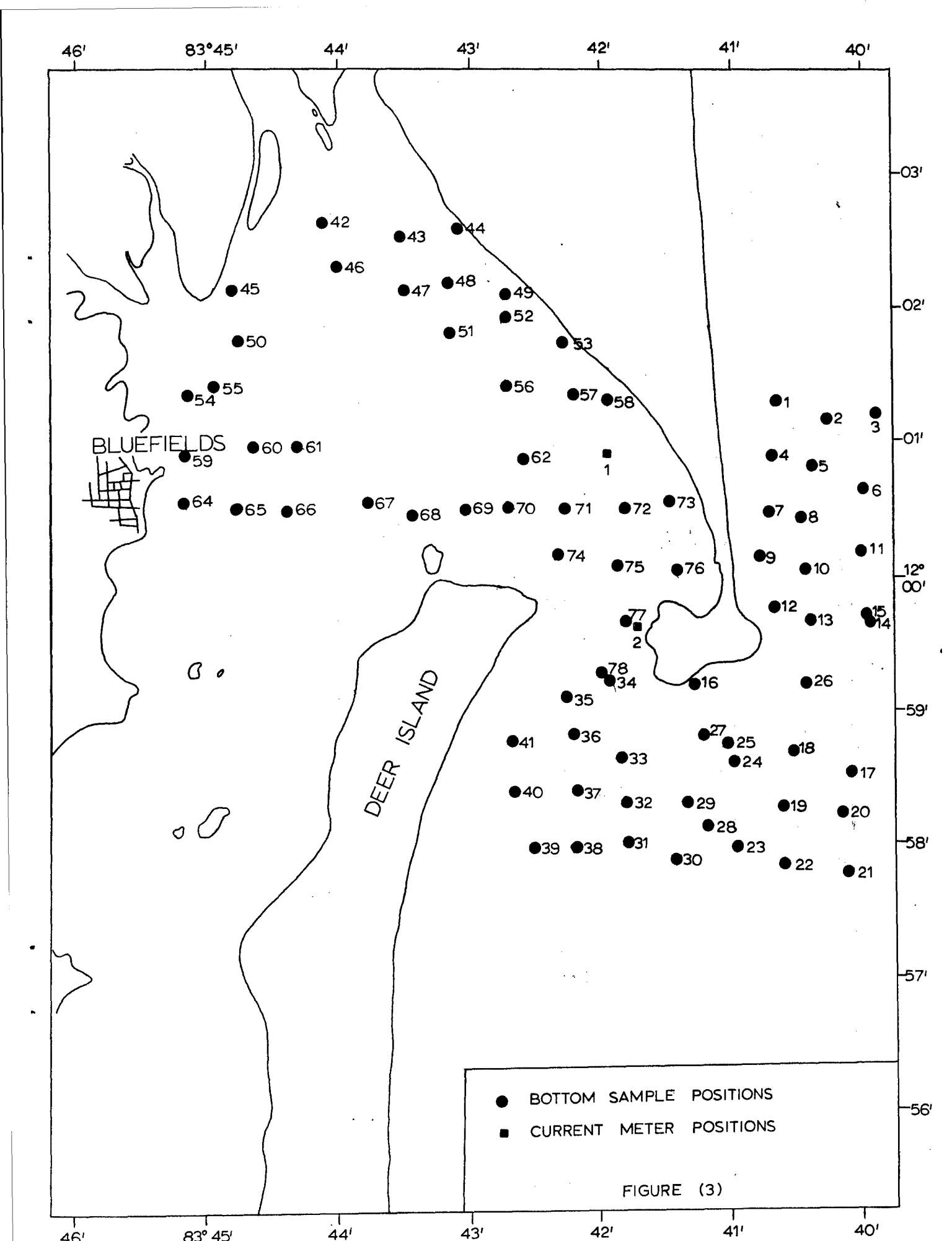
12° 00'
59'
58'
57'
SHEET 0.002
BLUEFIELDS BAY
BLUEFIELDS
DEER ISLAND
NOT SURVEYED-HEAVY BREAKERS
SHEET 0.001
AREA OF DEVELOPMENT

FIGURE (2)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BOTTOM SAMPLE POSITIONS
CURRENT METER POSITIONS

FIGURE (3)

BLUEFIELDS

1	Bluff - Fat - End 07°45' - 82°56'	Mud
2	13°20' - 65°28'	Mud
3	14°40' - 48°32'	Mud with shells
4	13°56' - 106°16'	Mud
5	20°00' - 78°31'	Mud with shells
6	23°18' - 55°45'	Mud with shells
7	32°41' - 100°18'	Mud
8	36°27' - 73°46'	Mud
9	79°44' - 60°30'	Mud
10	52°35' - 45°51'	Mud
11	33°15' - 43°19'	Mud
12	76°34' - 22°46'	Mud
13	49°01' - 26°06'	Mud with shells
14	32°35' - 29°06'	Mud with shells
15	Bluff - Fat - Fin 32°37' - 18°00'	Fine sand with shells, dark green
16	Deer - Ker - Rosa 23°19' - 36°16'	Mud with shells, dark green
17	Deer - Ker - Bluff 24°32' - 30°57'	Fine sand with shells, dark green
18	27°40' - 44°09'	Coarse mud, dark green
19	31°20' - 44°00'	Coarse mud, dark green
20	26°29' - 33°02'	Fine sand with shells, dark green

21	27°03' - 30°58'	Fine sand with shells, dark green
22	Deer - Ker - Bluff 32°35' - 39°24'	Coarse mud, dark green
23	38°13' - 47°17'	Coarse mud, dark green
24	Deer - Vilma - New 26°58' - 20°22'	Coarse mud, dark green
25	Deer - Ker - Rosa 34°35' - 32°51'	Fine sand, dark green
26	Deer - Rosa 21°29' - 04°31'	Fine grain sand, dark green
27	Deer - Ker - Rosa 36°13' - 83°38'	Fine sand, dark green
28	Deer - Ker - Bluff 42°31' - 55°52'	Very fine sand, dark green
29	46°13' - 64°16'	Coarse mud, dark green
30	47°33' - 51°16'	Coarse mud, dark green
31	Deer - Vilma - New 40°46' - 23°20'	Soft fine mud, dark green
32	42°24' - 27°25'	Soft fine mud, dark green
33	42°18' - 34°32'	Fine mud, dark green
34	33°04' - 41°22'	Fine sand, dark green
35	42°34' - 59°17'	Soft fine mud, dark green
36	51°57' - 46°42'	Fine sand, dark green
37	56°14' - 32°40'	Soft fine mud, light brown
38	50°26' - 24°31'	Fine mud, dark green w/gray
39	63°28' - 22°47'	Coarse mud, dark green
40	86°14' - 31°52'	Fine mud, dark green
41	85°34' - 53°46'	Fine sand, dark brown

42	Bluff - Jafqui - Aqua 26°25' - 67°44'	White Oyster shells
43	34°18' - 64°54'	Fine mud, gray
44	38°13' - 57°14'	Fine mud, gray
45	18°08' - 84°07'	Fine mud, gray
46	28°23' - 76°13'	Fine sand, gray
47	37°29' - 73°35'	Fine mud with shells, gray
48	42°26' - 65°46'	Fine mud, gray
49	49°05' - 57°36'	Fine mud, gray
50	16°49' - 105°07'	Fine mud, gray
51	47°15' - 72°36'	Fine mud, gray
52	53°14' - 58°42'	Fine mud, gray
53	61°37' - 49°15'	Fine mud, grown
54	Bluff - Stalucia - Aqua 64°50' - 79°10'	Fine mud gray
55	Sta. Lucia - Church - Aqua 36°29' - 37°28'	Fine mud, gray
56	Bluff - Jafqui - Aqua 66°05' - 60°51'	Fine mud, gray
57	Bluff - Casaya - Jafqui 27°53' - 47°09'	Fine mud, brown
58	29°50' - 45°36'	Fine mud, brown
59	Sta. Lucia - Church - Aqua 56°44' - 57°30'	Mud, brown
60	54°42' - 31°30'	Fine mud, gray
61	49°16' - 23°59'	Fine mud, gray
62	Bluff - Casaya - Jafqui 28°21' - 65°59'	Mud. dark gray
63	Position not available	

64	Jafqui - St. Lucia - Church 75°05' - 102°04'	Fine mud, brown
65	93°00' - 79°27'	Fine mud, brown
66	104°44' - 63°54'	Fine mud, brown
67	Jafqui - Sta. Lucia - Aqua 97°33' - 60°16'	Fine mud, brown
68	84°45' - 51°08'	Fine mud, brown
69	Bluff - Jafqui - Aqua 103°43' - 64°34'	Fine mud, brown
70	119°38' - 42°29'	Fine mud, brown
71	Bluff - Casaya - Jafqui 38°44' - 86°12'	Sand, brown
72	50°02' - 101°49'	Mud, brown
73	51°11' - 48°52'	Fine mud, brown
74	41°47' - 112°33'	Fine mud, brown
75	73°36' - 76°11'	Fine mud, brown
76	85°50' - 43°52'	Fine mud, brown
77	Bluff - Mast - Casaya 66°20' - 77°20'	Shells, white
78	Casaya - Mast - Mable 54°35' - 52°22'	Fine mud, gray

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13. ABSTRACT

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